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Domain structure of β-glycine single crystals

D.S. Vasileva[1], S.G. Vasilev[1], P.S. Zelenovskiy[1], V.Ya. Shur[1], A.L. Kholkin[1,2]

[1]*School of Natural Sciences, Ural Federal University, 620000 Ekaterinburg, Russia*

daria.s.vasileva@gmail.com

[2]*Physics Department & CICECO – Aveiro Institute of Materials, University of Aveiro, 3810-193 Aveiro, Portugal*

Recent studies of the simplest amino acid glycine (NH_2CH_2COOH) single crystals revealed that among three polymorphic phases α, β and γ formed at ambient conditions, only β-phase possesses both piezoelectric and ferroelectric properties [1]. The faceted crystals with in-plane polar axis were grown from aqueous solution via drop drying on Pt/SiO/Si substrate in air with controlled relative humidity. The detail experimental study of the neutral and charged domain walls in β-glycine microcrystals using atomic force (AFM) and piezoresponse force microscopy (PFM) was realized by scanning probe microscopes Ntegra Aura (NT-MDT, Russia) and Asylum MFP 3D SA (Asylum Research, USA).

Three types of as-grown domain structure were found: (1) striped domains with flat charged domain walls (Fig. 1a), (2) quasiperiodic ensembles of submicron width needle domains (Fig. 1b) and (3) large area domains with irregular shaped domain walls (Fig. 1c). The formation of as-grown domain structure with flat charged domain walls and a smooth change in orientation near the crystal edges can be attributed to growth layers located perpendicular to the polar axis and representing a periodic change in the composition or concentration of impurities [2,3]. The polarization direction is determined by the gradient sign of the composition or concentration, so the domain walls are localized at the places where the gradient sign changes. The formation of two other types of the as-grown domain structure can be attributed to switching the polarization in the striped domains under the action of the pyroelectric field E_{pyr}, which appears when the temperature of the crystal changes [3].

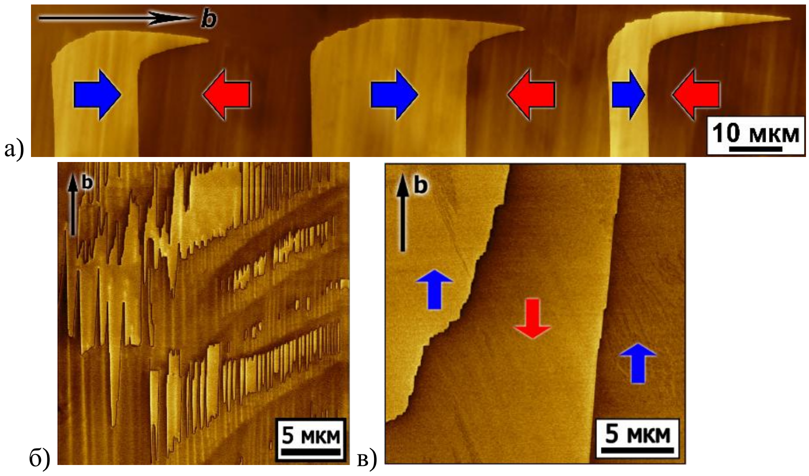

Figure 1. LPFM images of the as-grown domain structure types: (a) striped domains with flat charged domain walls, (b) quasiperiodic ensembles of submicron width needle domains, (c) large area domains with irregular shaped domain walls.

The shallow wells of 0.2-1 nm-depth and about 150 nm-width were revealed along the charged walls. The formation of these features was attributed to selective etching by water layer appeared at the surface in humid air. In contrast the pits appeared at neutral domain walls are due to deformation of the crystal lattice in the vicinity of the wall.

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